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(54) Method of producing medium-grade coated paper for web offset printing

(57) A method of producing medium-grade coated paper for web offset printing, in which paper having reduced heatset roughening is produced at low cost comprises applying a coating composition to both surfaces of a base paper containing high yield pulp(s) in an amount of 10 to 100% by weight, and chemical pulp(s) optionally in an amount of 0 to 90%, by weight, thereof. The coating composition contains natural ground calcium carbonate having a specific surface area of 1.5 to 5 m^2/g under the following conditions:

(i) when the specific surface area is 1.5 to 2.5 m^2/g: the amount used is 10% to (90S–125)% by weight, of the total pigments in the coating composition ("S" representing the specific surface area in m^2/g of the natural ground calcium carbonate).

(ii) when the specific surface area is 2.5 to 5 m^2/g: the amount used is 10 to 100% by weight, of the total pigments in the coating composition;

the high yield pulp or pulps used having a 42-mesh on fiber fraction content of below 30% by weight, and preferably a 150-mesh through fiber fraction content of below 80%.

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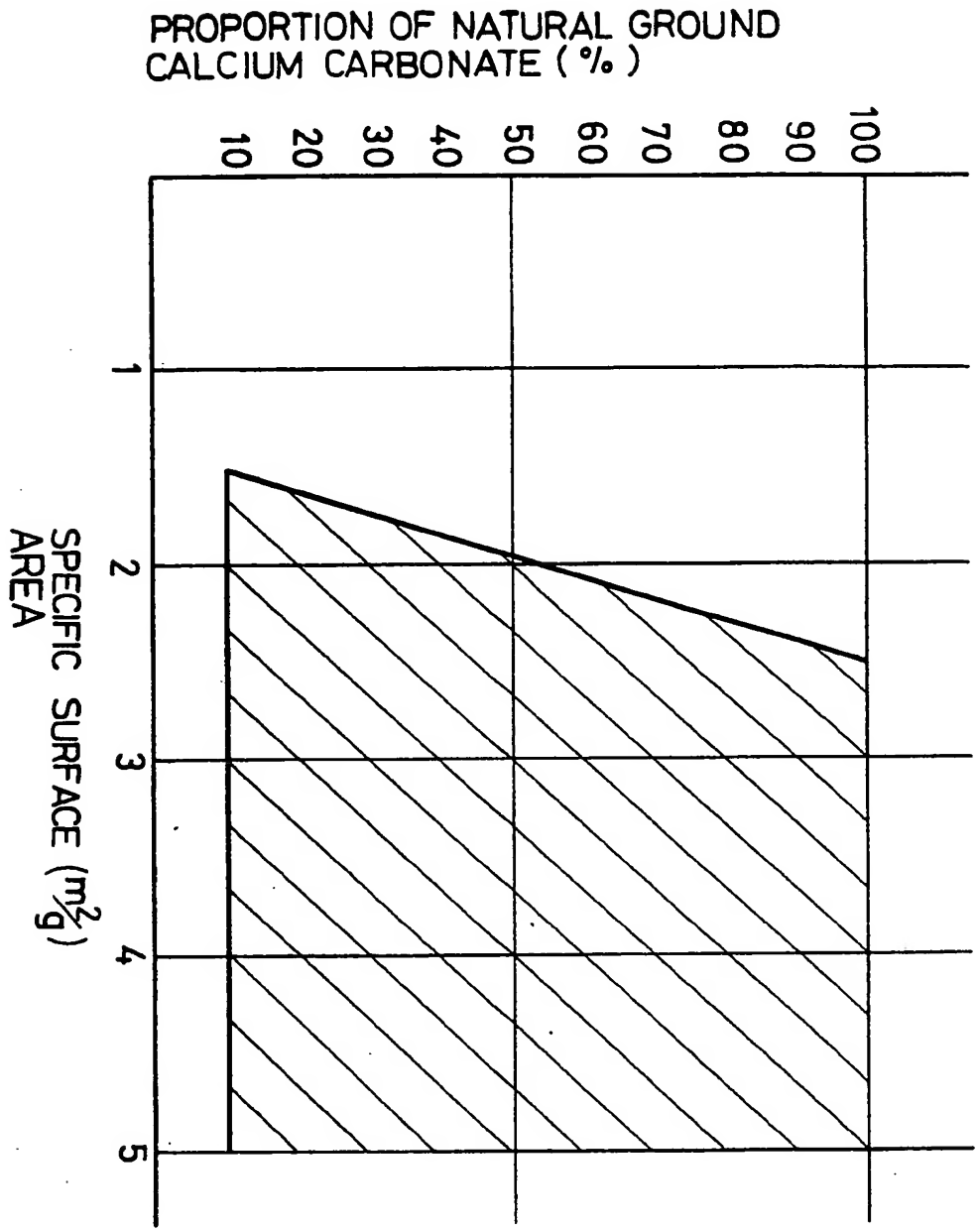
PROPORTION OF NATURAL GROUND CALCIUM CARBONATE (%)
10
20
30
40
50
60
70
80
90
100
SPECIFIC SURFACE AREA (m²/g)
1
2
3
4
5

SPECIFICATION

M thod of producing medium-grade coated paper for web offset printing

The present invention relates to a method of producing medium-grade coated paper for web offset printing, the base paper of which contains high yield pulps.

Recently, the importance of coated paper for printing as a medium for publication, advertisement, publicity and the like, has been reperceived. Particularly, the demand for coated paper of grade No. 3, No. 4 or No. 5, as set out, for example, in "Pulp and Paper" for May 1977, page 1977, (hereinafter referred to as "medium-grade coated paper") has been rapidly increasing because of the need for reducing the weight and cost of paper. In general, medium-grade coated paper is widely used in the field of light weight paper of weight 45 to 80 g/m² as compared with high-grade (grade No. 1 or No. 2) coated paper whch does not contain high yield pulps. In order, therefore, to compensate for the reduction of opacity resulting from the decrease in paper weight and to reduce the cost of paper, the base paper of medium-grade coated paper contains as 5 to 100% by weight of its pulp composition, high yield pulps of the following kinds: mechanical pulp (hereinafter referred to as "MP") such as stone-ground pulp (hereinafter referred to as "SGP"), pressure stone-ground pulp (also hereinafter referred to as "SGP"), refiner-ground pulp (hereinafter referred to as "RGP"), or thermo-mechanical pulp (hereinafter referred to as "TMP"); chemi-mechanical pulp (hereinafter referred to as "CMP"), such as chemi-thermo-mechanical pulp (hereinafter referred to as "CTMP") or chemi-ground pulp ("hereinafter referred to as "CGP"); and semi-chemical pulp (hereinafter referred to as "SCP").

In many cases, medium-grade coated paper because of its intended use is subjected to web offset printing, which is a high-speed printing process. However, web offset printing, in which continuous hot drying is performed after printing, is liable to produce the unfavorable phenomena of blistering and heat-set roughening, which are not apparent in other printing processes, such as sheet offset printing, rotogravure printing and letter press printing. These phenomena are serious disadvantages exerting a bad influence upon the printing.

Blistering is visible in both high-grade and medium-grade coated papers, and has been found to be attributable to the fact that, in the hot drying process conducted immediately after printing, moisture remaining in the base paper is instantaneously evaporated by a heat at a temperature exceeding 100°C and the expanded vapour pushes up the paper surface. A number of methods for eliminating such blistering have been suggested.

Heat-set roughening, a phenomenon in which the paper surfaces become rough after web offset printing, is seen only in medium grade coated paper, not in high-grade coated paper. Neither the causes of such heat-set roughening nor remedies therefore have as yet been adequately clarified, and this phenomenon has been considered to be the most difficult technical problem involved in the manufacture of medium-grade coated paper for web offset printing.

The present Applicants, amongst others, have made a continued study for a long period of time with a view to reducing heat-set roughening. As a result, it has been found that, even if fibre bundles, sheaves and the like of high yield pulps, which were considered to be the main cause of heat-set roughening, are removed from the pulp composition, heat set roughening still occurs when a coating composition on both surfaces has a weight of above 16 g/m², and this tendency is more noticeable when the coating composition has been applied by means of a blade coater. Further study has revealed that heat-set roughening is attributable to the essential difference in properties between the high-yield pulps and chemical pulps contained in the base paper. In fact, the causes of heat-set roughening are as follows: under the drying and finishing conditions for coated paper required to obtain the desired smoothness and gloss, the high yield pulps in the base paper contain more moisture than the chemical pulps therein, and therefore in the hot drying process used in web offset printing, the moisture contained, not only in sheaves of the high yield pulps, but also in single fiber pieces of such pulps, evaporates instantaneously; moreover, the fibres of the high yield pulps are very rigid and their bonding strength is small.

On the basis of these findings, the Applicants have made further studies, not only of the base paper, but also of the coating composition, in order to reduce heat-set roughening in the medium-grade coated paper for web offset printing. As a result, the Applicants have successfully obtained medium-grade coated paper in which heat-set roughening is reduced, by using in base paper high yield pulps having a particular fiber length distribution and by using a coating composition comprising natural ground calcium carbonate in a limited proportion.

It is, therefore, an object of the present invention to provide a method of producing medium-grade coated paper for web offset printing, in which paper heat-set roughening has been reduced.

It is another object of the present invention to provide a method of producing medium-grade coated paper of excellent quality at very small cost.

According to the present invention, there is provided a method of producing medium-grade

coated paper for web offset printing, which comprises applying a coating composition to both surfaces of a base paper so that a coating weight on both surfaces thereof (as solid matter) above 5 g/m² is obtained, said coating composition containing natural ground calcium carbonate having a specific surface area of 1.5 m²/g to 5 m²/g under the following conditions:

(i) when said specific surface area is from 1.5 m²/g to 2.5 m²/g, the amount used is 10% to (90S−125)% by weight of total pigments, where "S" represents the specific surface area in m²/g;

(ii) when said specific surface area is from 2.5 m²/g to 5m²/g, the amount used is 10% to 100% by weight of the total pigments;

said base paper containing one or more high yield pulps in an amount of 10% to 100% by weight, and optionally one or more chemical pulps in an amount of 0% to 90%, the total proportion of said high yield pulp or pulps retained as a 12-mesh fiber fraction, a 24-mesh fiber fraction and 42-mesh fiber fraction in screening performed in accordance with the "Method of Screening Test of Paper Pulp" as set forth in JIS (Japanese Industrial Standard) P8207, being below 30% by weight.

For the sake of brevity, this total proportion will hereinafter be referred to as "42-mesh on fiber fraction content".

The invention will be further described with reference to the drawing, which is a graph showing the relationship between the specific surface area and the proportion of natural ground calcium carbonate used as a pigment in a coating composition. In the coating compositions used in the present invention, the specific surface area and the proportion of natural ground calcium carbonate are selected from the shaded portion in this graph.

The high yield pulps used in the present invention are conventional high yield pulps such as MP (SGP, RGP TMP or the like), CMP (CTMP or the like) or SCP, and consist of unbleached pulps, and/or semibleached pulps and/or bleached pulps which are widely used *inter alia* in newsprint paper, paper board, medium-grade paper, medium-grade coated paper, and groundwood paper. In the present invention only high yield pulps are used which, irrespective of their type, are below 30%, or preferably below 20%, or more preferably below 10% in 42-mesh on fiber fraction content. High yield pulps generally used in paper making have 42-mesh on fiber fraction contents as follows: approximately 25 to 40% for SGP, approximately 30 to 60% for RGP, and approximately 35 to 75% for TMP. In the present invention, high yield pulps are adapted so as to have the above-mentioned 42-mesh on fiber fraction contents by properly adjusting the manufacturing conditions of the high yield pulps, refining conditions, screening conditions, post refining conditions, and so on. In particular, high yield pulps with a 42-mesh on fiber fraction content of below 5% are most preferred because they combine with the specific coating composition of the present invention to reduce heat-set roughening very remarkably. If the 42-mesh on fiber fraction content is too low, however, the yield of pulp is reduced and additional power is required for refining, post-refining, and so on. The 42-mesh on fiber fraction content is therefore adjusted according to the desired quality of the medium-grade coated paper to be produced, the proportion of high yield pulp, the content of coating composition, and similar parameters. Among high yield pulps having the required 42-mesh on fiber fraction contents, a high yield pulp which has a content below 80%, preferably below 70%, of fiber fractions passing through a 150-mesh screen (hereinafter refered to as "150-mesh through fiber fraction content") is preferred because it effectively reduces heat-set roughening and prevents blistering. When more than one kind of high yield pulp is used in the present invention, the 42-mesh on fiber fraction content and the 150-mesh through fiber fraction content are determined after the high yield pulps are mixed together. Lignin is sometimes removed from high yield pulps by oxidation or deoxidization. Because, in this case, the high yield pulps become like a chemical pulp, heat-set roughening is reduced, but the original objects of improving opacity and reducing paper cost by using high yield pulps cannot be attained. Such treatment, therefore, is preferably limited to an extent such that the high yield pulps show a brightness of below 80% when determined by means of a Hunter multipurpose reflectometer, and this applies also to the case of bleached waste paper.

The base paper for medium-grade coated paper used in the present invention contains high yield pulps in an amount of at least 10% by weight, and may be produced as follows, the high yield pulps are mixed with chemical pulp, waste paper pulp, broken pulp, and the like, and, according to need, with auxiliary agents such as fillers, sizes, retention aids, paper strengthening agents, dyestuffs, alum, pitch control agents, and anti-foaming agents. The pulp composition thus prepared is then made into paper under acid or alkaline conditions by means of a conventional single-wire or double-wire paper-making machine. Alkaline paper making is preferred from the point of view of reutilizing brokes. If necessary, it is possibl to apply starch, polyvinyl alcohol, polyacrylamide, or the like, as a surface size by means of a size press, gat roll coater or similar device during the paper-making process.

The coating composition applied to the base paper thus obtained contains pigments and adhesives as its chief ingredi nts as in conv ntional coating compositions. In accordance with

the present invention, however, the coating composition contains natural ground calcium carbonate having a specific surface area of 1.5 m^2/g to 5 m^2/g, in an amount of 10 to 100% by weight, of the total pigments. When the specific surface area of the natural ground calcium carbonate is in the range of 1.5 to 2.5 m^2/g, the upper limit of the amount thereof used is (90S−125)%, by weight, of the total pigments, where "S" represents the particular value of specific surface area of the natural ground calcium carbonate.

If a natural ground calcium carbonate having a specific surface area of below 1.5 m^2/g is used, or if natural ground calcium carbonate having a specific surface area of 1.5 m^2/g to 2.5 m^2/g is used in an amount excess of the aforesaid range, heat-set roughening is reduced, but the smoothness of the coated surfaces is seriously affected, printed matter obtained therfrom being inferior in printed surface smoothness and ink gloss despite the reduction in heat-set roughening. Consequently, in the present invention, natural ground calcium carbonate having a specific surface area of above 1.5 m^2/g is used in amounts within the aforesaid range. In the case of natural ground calcium carbonate having a specific surface area of above 5 m^2/g, ink gloss and printed surface strength are reduced, and it is therefore necessary to increase the amount of adhesives in the coating composition, which results in a rise in production cost and an increase in heat-set roughening. Consequently, in the present invention, natural ground calcium carbonate having a specific surface area of less than 5 m^2/g is used.

Natural ground calcium carbonate can be made as follows: limestone, sparite, micrite, marble, calcite, natural chalk, or the like, is ground into fine particles once or several times, by a dry or wet process using mechanical means, such as a crusher, pebble mill, hammer mill, micron mill, ball mill, jet mill, attritor, sand mill, attrition mill, or similar device, and is, as required, classified by air elutriation, or hydraulic elutriation, for example, and is further condensed and dried. Natural ground calcium carbonate for paper coating which is thus obtained in the form of a slurry or dry powder, is used in the present invention.

Particularly, it is preferred to use natural ground calcium carbonate processed to satisfy formula (1) below, and more preferably, formula (2) below, as is disclosed in Japanese Patent Specifications No. Sho 53–81709, and Sho 53–40462, by being mechanically ground by a wet process, either continuously or batchwise, by means of a sand mill, attrition mill, attritor, agitation mill, or like device with natural or synthetic particles, not exceeding about 5 mm in diameter, such as Ottawa sand, glass beads, ceramic beads, silicate beads, and zirconium beads, as a grinding medium (hereinafter referred to as "sand mill treatment")

$$P \geqq \frac{0.5}{N} + N \qquad (1)$$

$$P \geqq \frac{0.8}{N} + N \qquad (2)$$

where "N" represents the specific surface area in m^2/g before the sand mill treatment, and "P" represents the specific surface area in m^2/g after the sand mill treatment.

A coating composition containing such natural ground calcium carbonate caused by said sand mill treatment to have a specific surface area of above 2 m^2/g is excellent as far as fluidity, water retention, and freedom from streaks are concerned and, even if such natural ground calcium carbonate is used in a high proportion of above 20% by weight of the total pigments, coated surface smoothness, printed surface smoothness and ink gloss are maintained in good condition.

Pigments contained along with the natural ground calcium carbonate in the coating compositions of the present invention may be conventional pigments for paper coating such as kaolin, clay, barium sulfate, precipitated calcium carbonate, aluminium hydroxide, satin white, titanium dioxide, calcium sulfite, zinc sulfate, and plastic pigments, mixed according to their respective properties. It is to be understood that these are merely examples and the pigments used in the present invention are not in any way limited thereto. In the present invention, one or more kinds of adhesives may be used, according to the desired paper quality, selected from conventional adhesives for paper coating, such as natural adhesives including casein, soya-bean protein, yeast protein, starch, oxidised starch, esterified starch, etherified starch, cationic starch, other modified starches and cellulos derivatives; and synthetic resin adhesives including conjugated diene copolymer latexes such as styrene-butadiene copolymers and methyl methacrylate-butadiene copolymers, acrylic polymer latexes such as polymers and copolymers of acrylic and/or methacrylic acid esters, polyvinyl acetate latexes sych as ethylene-vinyl acetate copolymers, and other alkali non-sensitive or alkali-sensitive synthetic resin emulsions. In general, the adhesives are used in a range of 5 to 25 parts by weight to 100 parts by weight of pigments. However, it is desirable to use adhesives in a range of 10 to 20 parts by weight to 100 parts by

weight of pigments in order to obtain excellent smoothness, opacity, paper gloss and ink gloss by increasing the coating weight, and to r duce heat-set roughening. It is, of course, possibl to mix the coating composition, as required, with such auxiliary agents such as dispersants, flow modifiers, anti-foaming agents; dyestuffs, lubricants, insolubilizers and water retention agents, as are contained in conventional coating compositions.

In the method of the present invention, the base paper is single-coated or multiply coated on both surfaces with the coating composition by means of a machine or hand coater so that the coating weight on both surfaces is above 5 g/m². The make-up of the coating composition on each surface and that of the coating compositions forming the various layers in a multi-layer coating may be suitably varied if desired. Coating may be carried out by any process and by means of any conventional coating machine, for instance, an air knife coater, a roll coater, a puddle-type or inverted blade coater with bevel or bent blade, a bill blade coater, a twin blade coater, or a Champflex coater.

Among these costing machines, the blade coaters in particular have preferably been used in producing high-quality coted papers because they give smoother coated surfaces. However, if the blade coaters are used in the production of medium-grade coated paper for web offset printing, the possibility of heat-set roughening increases, particularly when the coating weight on both surfaces is above 16 g/m², because the pigments in the coating composition are liable to exhibit orientation and the vapor permeability of the coated layers is decreased. Consequently, to obtain medium-grade coated paper without heat-set roughening using the blade coaters, it has been generally considered necessary, for instance, to reduce the coating weight at the sacrifice of paper quality, including paper gloss, smoothness and ink gloss, or to reduce the moisture in the product considerably. However, by proceeding in accordance with the present invention, it is not necessary to take such measures as decreasing the moisture in the product even when the coating weight on both surfaces is above 24 g/m², and it is possible to finish m dium-grade coated paper for web offset printing having excellent paper gloss, smoothness and ink gloss by means of finishing machines, such as a machine calender, super calender or gl ss calender.

It is not clear why such advantages are obtained, but it is surmised that it is because a very good balance is maintained between the quality of the medium-grade coated paper, such as paper gloss, smoothness and ink gloss, and the reduction of heat-set roughening, owing to the improvement of vapor permeability, by applying the coating composition, containing natural ground calcium carbonate with a certain specific surface area in a limited proportion, onto the base paper which has reduced heat-set roughening because it contains high yield pulps with a particular fiber length distribution.

Thus, by proceeding in accordance with the present invention, it is possible to reduce heat-set roughening and to obtain medium-grade coated paper of excellent quality for web offset printing. Furthermore, particularly when the coating composition contains natural ground calcium carbonate in an amount above 20% by weight thereof, coated paper with high brightness can be obtained; it is possible therefore to put a larger quantity of low-priced high yield pulps into the base paper and to produce medium-grade light-weight coated paper having good opacity at very small cost.

The invention is illustrated by the following non-limitative examples. In the examples, all parts or percentages are by weight, unless otherwise stated.

Inventive Example 1

Base paper of 40 g/m² for medium-grade coated paper was obtained from paper material comprising 1 part rosin size, 3 parts alum and 5 parts talc filler respectively added to a pulp composition consisting of 15 parts SGP, treated by after-refining, to have a 42-mesh on fiber fraction content of 4% and a 150-mesh through fiber fraction content of 67%, 65 parts of needle-leaved bleached kraft pulp (hereinafter referred to as "NBKP") having a Canadian Standard Freeness (hereinafter referred to as "CSF") of 550 CC and 20 parts braod-leaved bleached kraft pulp (hereinafter referred to as "LBKP") having a CSF of 450 CC (the last three "parts" mean parts by weight of bone dry pulp.) A coating composition with a concentration of 60% was obtained by dispersing 15 parts natural ground calcium carbonate with a specific surface area of 1.8 m²/g ("Super 1700" made by Maruo Calsium. Co., Japan) and 85 parts kaolin ("UW-90" made by Engelhard Minerals & Chemicals Corporation, USA) in water with 0.2 part sodium polyacrylate as dispersant so as to give a solid matter concentration of 65% , and further adding thereto 10 parts cooked oxidized starch "MS3800" made by Nippon Shokuhin Kako KK, Japan) in the form of solid matter and 7 parts styrene-butadiene copolymer latex ("JSR-0697" made by Japan Synthetic Rubber Co., Ltd, Japan) in the form of solid matter. The coating composition was applied to the base paper by means of a blade coater so as to give a dry coating w ight on both surfaces of 24 g/m². Then, the paper was dri d, and treated by a super-calender. Thus, medium-grade coated paper of 64 g/m² weight was obtained. The medium-grade coated paper was put to paper quality tests, the results of which

are shown in Table 1 below.

The specific surface area of the natural ground calcium carbonate was measured as foll ws by means of a powder surface area d terminator (made by Shimadzu-Corp. Japan); a 3g sample was put into a sample tube 2 $cm^2 \times 1cm$ in size, and the specific surface area was calculated from the time required for 20 cc of air to pass through it using a 600 mm water column. (In all of the following examples, the specific surface area of natural ground calcium carbonate was measured in this way).

In comparative Example 1, medium-grade coated paper was obtained in the same way as in Inventive Example 1, except that the proportions of natural ground calcium carbonate and kaolin in the coating composition were changed to 30 parts and 70 parts respectively. The medium-grade coated paper thus obtained was put to paper quality tests, the results of which are shown in Table 1.

Inventive Example 2

Base paper for medium-grade coated paper was obtained in the same way as in Inventive Example 1, except that the pulp composition consisted of 35 parts RGP treated to have a 42-mesh on fiber fraction content of 9% and a 150-mesh through fiber fraction content of 51%, 40 parts NBKP having a CSF of 55 CC and 25 parts LBKP having a CSF of 450 CC.

A coating composition was obtained in the same way as in Inventive Example 1 except that 40 parts natural ground calcium carbonate with a specific surface area of 1.9 m^2/g, ("Escalon 2000" made by Sankyo Seihum KK., Japan) and 60 parts kaolin ("HT Clay" made by EMC, USA) were used as pigments. The coating composition was applied to the base paper and dried in the same way as in Inventive Example 1. The coated paper was treated by means of a super-calender to obtain medium-grade coated paper. The medium-grade coated paper thus obtained was put to paper quality tests, the results of which are shown in Table 1.

In Comparative Example 2, medium-grade coated paper was obtained in the same way as in Inventive Example 2, except that the 42-mesh on fiber fraction content of RGP was 35%. The medium-grade coated paper thus obtained was put to paper quality tests, the results of which are shown in Table 1.

Inventive Example 3

Base paper for medium-grade coated paper was obtained in the same way as in Inventive Example 1 except that the pulp composition consisted of 35 parts TMP treated to have a 42-mesh on fiber fraction content of 9% and a 150-mesh through fiber fraction content of 42%, 32.5 parts NBKP having a CSF of 550 CC, and 32.5 parts LBKP having a CSF of 450 CC. Natural ground calcium carbonate with a specific surface area of 1.5 m^2/g ("Softon 1500" made by Bihoku Funka Co., Japan) was treated to have a specific surface area of 2.1 m^2/g by dispersing it in water by means of a turbine-type agitator and with 0.2% sodium polyacrylate as dispersant so as to give a solid matter concentration of 70%, and by grinding the slurry thus obtained by means of a sand grinder (model "32G" made by Igarashi Kikai Seizo Co., Ltd., Japan) at a speed of 1,000 rpm and a flow of 400 liters per hour, and with glass beads of about 2.5 mm in average diameter as a grinding medium. A coating composition was obtained in the same way as in Inventive Example 1 except that 50 parts natural ground calcium carbonate thus obtained and 50 parts kaolin ("Hydrasheen 90" made by Huber Corporation, USA) were used as pigments. The coating composition was applied to the base paper and dried in the same way as in Inventive Example 1.

The coated paper was treated by means of a super-calender to obtain medium-grade coated paper. The medium-grade coated paper thus obtained was put to paper quality tests, the results of which are shown in Table 1.

In comparative Example 3, medium grade coated paper was obtained in the same way as in Inventive Example 3 except that the pigments in the coating composition consisted of 75 parts natural ground calcium carbonate and 25 parts kaolin. The medium-grade coated paper thus obtained was put to paper quality tests, the results of which are shown in Table 1.

Inventive Example 4

Base paper of 35 g/m^2 for medium-grade coated paper was obtained from paper material comprising 0.5 parts rosin size, 3 parts alum, 3 parts kaolin filler and 0.3 part of polyacrylamide resin as a paper strengthening agent, respectively added to a pulp composition consisting of 30 parts TMP treated to have a 42-mesh on fiber fraction content of 25% and a 150-mesh through fiber fraction content of 35%, 20 parts SGP which was the same as used in Inventive Example 1 and 50 parts NBKP which was also the same as used in Inventive Example 1.

Natural ground calcium carbonate with a specific surface area of 1.5 m^2/g ("Softon 1500" made by Bihoku Funka Co., Japan) was treated to have a specific surface area of 2.3 m^2/g by dispersing it in water with a dispersant so as to give a solid matter concentration of 60%, and by treating the slurry thus obtained by means of an attrition mill having silicate beads of about 1

mm average diameter. A coating composition was obtained in the same way as in Inventive Example 1 except that 75 parts natural ground calcium carbonate thus obtained and 25 parts kaolin ("UW-90" made by EMC, USA) were used as pigments. The coating composition was applied to the base paper and dried in the same way as in inventive Example 1. The coated paper was treated by means of a super-calender to obtain medium-grade coated paper. The medium-grade coated paper thus obtained was put to paper quality tests, the results of which are shown in Table 1.

In comparative Example 4, medium-grade coated paper was obtained in the same way as in Inventive Example 4 except that the pigment in the coating composition consisted of 100 parts natural ground calcium carbonate. The medium-grade coated paper thus obtained was put to paper quality tests, the results of which are shown in Table 1.

Inventive Example 5

Base paper for medium-grade coated paper was obtained in the same way as in Inventive Example 1 except that the pulp composition consisted of 20 parts RGP treated to have a 42-mesh on fiber fraction content of 25% and a 150-mesh through fiber fraction content of 50%, 20 parts NBKP having a CSF of 450 CC. Natural ground calcium carbonate with a specific surface area of 0.1 m^2/g was treated to have a specific surface area of 3 m^2/g by dispersing it in water with 1.0% sodium polyacrylate as dispersant so as to give a solid matter concentration of 70%, and treating the slurry thus obtained by means of a sand mill. A coating composition was obtained in the same way as in Inventive Example 1 except that 100 parts natural ground calcium carbonate thus obtained was used as a pigment. The coating composition was applied to the base paper and dried in the same way as in Inventive Example 1. The coated paper was treated by means of a super-calender to obtain medium-grade coated paper. The medium-grade coated paper thus obtained was put to paper quality tests, the results of which are shown in Table 1.

Inventive Example 6

Base paper for medium-grade coated paper was obtained in the same way as in Inventive Example 1 except that the pulp composition consisted of 70 parts SGP treated to have a 42-mesh on fiber fraction content of 5% and a 150-mesh through fiber fraction content of 55% and 30 parts NBKP having a CSF of 550 CC. Natural ground calcium carbonate with a specific surface area of 0.08 m^2/g was treated to have a specific surface area of 4,5 m^2/g by dispersing it in water with 0.6% sodium polyacrylate and 0.2% tetrasodium pyrophosphate as dispersants so as to give a solid matter concentration of 73%, and treating the slurry thus obtained by means of a horizontal type sand mill ("Dynomill" made by Willy A. Bachofen AG, West Germany).

A coating composition with a solid matter concentration of 58%, comprising 100 parts natural ground calcium carbonate thus obtained, adhesives of 5 parts oxidized starch (solid matter) and 12 parts styrene-butadiene copolymer latex ("SN 304" made by Sumitomo Naugatuch Co., Ltd, Japan) (solid matter), some dyestuff, some anti-foaming agent and some insolubilizer, was applied to said base paper by means of a blade coater so as to give a dry coating weight on both surfaces of 26 g/m^2. Then, the paper was dried, and treated by a super-calender to obtain medium-grade coated paper. The medium-grade coated paper thus obtained was put to paper quality tests, the results of which are shown in Table 1.

Inventive Example 7

Medium-grade coated paper was obtained in the same way as in Inventive Example 1 except that the pulp composition consisted of 35 parts RGP treated to have a 42-mesh on fiber fraction content of 15% and a 150-mesh through fiber fraction content of 50%, and 65 parts LBKP having a CSF of 500 CC, and that the pigments in the coating composition consisted of 40 parts natural ground calcium carbonate treated to have a specific surface area of 2.5 m^2/g by means of an attritor, and 60 parts kaolin ("HT Clay" made by EMC USA). The medium-grade coated paper thus obtained was put to paper quality tests, the results of which are shown in Table 1.

Inventive Example 8

Base paper of 50 g/m^2 for medium-grade coated paper was obtained from paper material comprising 0.05 part of alkylketen dimer ("Hercon 40" made by Dic Hercules Co., Japan) as a size, 0.05 part of polyamide epichlorhydrin ("Kymene" made by Dic Hercules Co., Japan) as a fixing agent, 1.0 part paper of cationic starch as a strengthening agent and 3 parts of natural ground calcium carbonate as a filler, these materials being respectively added to a pulp composition consisting of 30 parts SGP treated to have a 42-mesh on fiber fraction content of 20% and a 150-mesh through fiber fraction content of 45%, 55 parts NBKP having a CSF of 450 CC.

A coating composition was obtained in the same way as in Inventive Example 1 except that the pigments therein consisted of 30 parts natural ground calcium carbonate whose specific surface area was changed from 1 m^2/g to 4 m^2/g by treatment at a concentration of 65% by means of an attrition mill, 50 parts kaolin ("HT Clay" made by EMC, USA) and 20 parts aluminium hydroxide ("Hiligilite H–42" made by Showa Denko KK, Japan). The coating composition was applied to the base paper and dried in the same way as in Inventive Example 1. The coated paper was treated by means of a super-calender to obtain medium-grade coated paper. The medium-grade coated paper thus obtained was put to paper quality tests, the results of which are shown in Table 1.

Comparative Example 5

Medium-grade coated paper was obtained in the same way as in Inventive Example 1 except that the pigment in the coating composition consisted of 100 parts kaolin. The medium-grade coated paper thus obtained was put to paper quality tests, the results of which are shown in Table 1.

Comparative Example 6

Medium-grade coated paper was obtained in the same way as in Inventive Example 2 except that the pigments in the coating composition consisted of 50 parts precipitated calcium carbonate ("PZ" made by Shiraishi Kogyo KK, Japan) and 50 parts kaolin ("HT Clay" made by EMC, USA). The medium-grade coated paper thus obtained was put to paper quality tests, the results of which are shown in Table 1.

Comparative Example 7

Medium-grade coated paper was obtained in the same way as in Inventive Example 1 except that the paper material comprised 1 part rosin size, 3 parts alum, 0.2 part polyacrylamide resin and 5 parts talc respectively added to a pulp composition consisting of 50 parts SGP treated, by after-refining, to have a 42-mesh on fiber fraction content of 0% and a 150-mesh through fiber fraction content of 85%, and 50 parts NBKP having a CSF of 550 CC. The medium-grade coated paper thus obtained was put to paper quality tests, the results of which are shown in Table 1.

As will be seen from Table 1, medium-grade coated paper obtained in each Inventive Example was satisfactory and well-balanced as regards heat-set roughening, printed surface smoothness, ink gloss, picking and blistering, as compared with medium-grade coated paper in any of the Comparative Examples.

The results of the paper quality tests shown in Table 1 were obtained as follows:

(1) *Gloss:* Gloss was measured at an angle of incidence of 75° by means of a specular gloss meter.

(2) *Heat-set roughening:* By means of an RI printing tester made by Akira Industry Co., Japan, 1 cc ink for web offset printing was distributed, and both surfaces of the medium-grade coated paper were printed therewith. Immediately after that, the paper was dried by heating both surfaces at a temperature of 200°C, and heat-set roughening on both surfaces was visually measured.

(3) *Printed surface smoothness:* The same procedure was taken as in (2) above except that the heating temperature was 150°C. The smoothness of the printed surface was visually measured.

(4) *Ink Gloss:* The ink gloss of the printed matter obtained in (3) above was visually measured.

(5) *Picking:* The medium-grade coated paper was printed with ink having a large value of tackiness, by means of an RI printing tester. Picking was visually measured.

(6) *Blistering:* The same procedure was followed as in (2) except that the heating temperature was 250°C. Blistering was visually measured.

(7) *Evaluation:* The results of the visual measurements in (2) to (6) are represented by the following four relative grades:

◎ . . . Very Good
○ . . . Good
Δ . . . Bad
× . . . Very Bad

TABLE 1

Inventive Example	Gloss	Heat-Set Roughening	Printed Surface Smoothness	Ink Gloss	Picking	Blistering
1	60	◎	○	○	○	○
2	50	◎	○	○	○	○
3	58	◎	○	○	○	○
4	48	○	○	○	○	○
5	42	○	○	○	○	○
6	50	◎	○	○	○	○
7	54	◎	○	○	○	○
8	57	◎	○	○	○	○
Comparative Example						
1	50	◎	Δ	Δ	○	○
2	45	×	×	×	○	○
3	88	◎	Δ	Δ	○	○
4	88	○	Δ	Δ	○	○
5	65	×	×	○	○	Δ
6	55	◎	○	×	×	○
7	60	○	Δ	○	○	×

CLAIMS

1. A method of producing medium-grade coated paper for web offset printing, which comprises applying a coating composition to both surfaces of a bone paper so that a coating weight on both surfaces thereof (as solid matter) above 5 g/m² is obtained, said coating composition containing natural ground calcium carbonate having a specific surface area of 1.5 m²/g to 5 m²/g under the following conditions:

(i) when said specific surface area is from 1.5 m²/g to 2.5 m²/g, the amount used is 10% to (90S−125)% by weight of the total pigments, where "S" represents the specific surface area in m²/g;

(ii) when said specific surface area is from 2.5 m²/g to 5 m²/g, the amount used is 10% to 100% by weight of the total pigments;

said base paper containing one or more high yield pulps in an amount of 10% to 100% by weight, and optionally on or more chemical pulps in an amount of 0% to 90%, the total proportion of said high yield pulp or pulps retained as a 12-mesh fiber fraction, a 24-mesh fiber fraction and a 42-mesh fiber fraction in screening performed in accordance with the "Method of Screening Test of Paper Pulp" as set forth in JIS (Japanese Industrial Standard) P8207, being below 30% by weight.

2. A method as claimed in Claim 1, wherein the proportion of said high yield pulp or pulps passing through a 150-mesh screen in screening performed in accordance with the "Method of Screening Test of Paper Pulp" as set forth in JIS P8207, is below 80%.

3. A method as claimed in Claim 1 or Claim 2, wherein said total proportion of said high yield pulp or pulps retained as said 12-mesh, 24-mesh and 42-mesh fiber fractions is below 20% by weight.

4. A method as claimed in Claim 3, wherein the total proportion of said high yield pulp or pulps is below 5% by weight.

5. A method as claimed in any one of the preceding Claims, wherein said natural ground clacium carbonate is treated to have a specific surface area of 2 m²/g to 5 m²/g by sand mill treatment, and the proportion of said natural ground calcium carbonate in said coating composition is above 20% by weight of the total pigments.

6. A method as claimed in any one of the preceding Claims, wherein the coating weight (as solid matter) of said coating composition on both surfaces of the base paper is above 16 g/m².

7. A method of producing medium-grade coated paper substantially as described with reference to any one of Inventive Examples 1 to 8.

8. Medium-grade coated paper produced by a method as claimed in any one of Claims 1 to 7.

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